Morphogenesis of some organs of the immune system of broiler chickens in the age aspect when adding the feed additive "Amber Chill feed supplement" to the diet

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Abstract. This article uses the results of a comparative morphological study of Ross 308 cross broiler chickens of the experimental and control groups when introducing the feed additive "Amber Chill feed supplement" with drinking water during the technological cycle. The experiments were conducted at the Ural Federal Agrarian Research Center Ural Branch of the Russian Academy of Sciences" in 2023. The inclusion of the feed additive "Amber Chill feed supplement" in the diet of broiler chickens did not have a negative effect on the general condition, safety of poultry, and live weight gain. The hematological parameters of broiler chickens of the control and experimental groups were within the reference values. Histological examination of the organs of the immune system – thymus, spleen, bursa of Fabricius at 10, 20, 35 and 42 days of age revealed the processes of maturation and differentiation of organs and some processes of involution by the end of the technological cycle. A distinctive feature between the groups was the earlier maturation of the immune system organs in broiler chickens of the experimental group, as opposed to the control group.

1 Introduction

It is known that poultry farming is the most "early-maturing" and profitable branch of animal husbandry. Industrial poultry farming in our country has reached the level of advanced foreign countries in all major parameters, and above all in terms of productivity. This became possible due to the use of specialized, highly productive breeds, crosses and lines of poultry, a high degree of mechanization and automation of labor-intensive processes, feeding with high-calorie complete feed, frequent change of poultry stock, which provides a uniform output [1].

At the present stage, in the context of market transformations, the strategic priority of economic development is to increase the level of food security of the state by increasing food production, improving their quality and nutrient balance, as well as ensuring the protection of producer interests. The food system must provide the population with high-quality food at

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affordable prices. The production of poultry meat in terms of price and quality, taking into account the purchasing power of the population, has always occupied a leading position [2].

In modern conditions of poultry farming, great attention is paid to the maximum preservation of the resulting young and increasing their productivity. High concentration of livestock in limited areas, year-round stay of poultry in enclosed spaces with cellular content leads to a violation of the microclimate, weakening of the constitution and health of the bird. This is accompanied by a decrease in physiological reactivity and natural resistance of the body, metabolic disorders, decreased productivity and safety, increased aggressiveness and the production of stress hormones that have a negative effect on the body, especially young birds. In this regard, the search for means and methods of preserving livestock, obtaining high-quality products in poultry farming are relevant [3].

In connection with the above, it can be said that the immunity of poultry will inevitably decrease and it is necessary to look for ways to maintain it at a level that will ensure the normal growth and development of poultry, as well as the possibility of increasing it. Currently, various biologically active additives are widely used, which are part of ready-made feeds, or are used as an addition to the basic diet. They have a beneficial effect on the general condition of the bird, contribute to increasing the body's resistance, and as a result contribute to better conservation of livestock and increased productivity. At the same time, we can get so-called "clean products" free of antibiotics and hormonal drugs.

The immune system of birds has a number of features. In the formation and realization of immunity, the most important are lymphoid organs, lymphoid tissue and a pool of circulating lymphatic cells [4, 5, 6].

In birds, lymphoid organs are divided into primary (central) and secondary (peripheral) according to the degree of functional activity and importance in the formation of an immune response, just like in mammals) [4, 7, 8, 9, 10, 11]. The primary organs include the bone marrow, thymus, cloacal (Fabricius) bursa [4, 5, 12, 13, 14, 15, 16]. In addition, a number of authors identify the embryonic yolk sac and the embryonic liver as early organs of hematopoiesis [4, 5, 17, 18]. Secondary organs of the immune system include the spleen, Harderian and lacrimal glands, as well as accumulations of lymphoid tissue located in the walls of the hollow organs of the digestive system (esophageal amygdala, Meckel's diverticulum, caecal tonsils, Peyer's plaques, single lymphoid nodules), respiratory and urinary systems. Peripheral lymphoid organs are located on the border with the external environment and on the pathways of blood and lymph circulation. The central organs of the immune system are located in well-protected areas of the animal's body [4, 19, 20, 21, 22, 23, 24, 25, 26].

2 Materials and methods

In the experiment, broiler chickens of the Ross 308 cross (n=60) of daily age were used, kept in the premises of the Ural Federal Agrarian Research Center Ural Branch of the Russian Academy of Sciences", from which the following groups were formed:

- control group (n=30) – the bird received water without the addition of feed additives;
- experimental group (n = 30) – the bird received the feed additive "Amber Chill feed supplement", which was introduced into the diet by adding drinkers to the water throughout the growing period at a dosage of 1.5 liters per 1000 liters of drinking water. Broiler chickens were watered from vacuum drinkers with tap water. The water quality corresponded to GOST standarts R 51232-98 [11].

The feed additive "Amber Chill feed supplement" (registration number of the Russian Federation-CD-00303) was used for the study. This feed additive is used to increase the safety and productivity of poultry in conditions of heat stress, to improve the quality of
bleeding of birds during slaughter. In appearance, it is a transparent colorless or almost colorless solution with a specific odor.

"Amber Chill feed supplement" contains as active ingredients: succinic acid 28000-38000 mg, sodium citrate 25000-35000 mg, salicylic acid 15000-30000 mg, potassium citrate 4000-5000 mg, malic acid 1000-5000 mg, pyridoxine 500-1500 mg, excipients: sorbitol 1000-4000 mg, potassium chloride 1000-5000 mg, purified water up to 1 liter. It does not contain genetically engineered organisms.

The feeding of poultry of both groups was identical – with compound feed of LLC "Poultry Farm Artemovskaya" from day 1 to 8 PC 5-1, from day 9 to 17 PC 5-2, from day 18 to 24 PC 6-1, from day 25 to 37 PC 6-2 and from day 38 to 42 PC 6-2-used.

The bird was kept in rooms with natural and artificial lighting and a controlled microclimate. The temperature and humidity regime during the experiment was maintained in the required range depending on the age of the bird: air temperature 20.7-33.0 °C; relative humidity 65-70%.

The safety and live weight gain of broiler chickens were assessed weekly.

Laboratory studies were carried out in the department of veterinary laboratory diagnostics with a testing laboratory and in the laboratory of Immunology and Pathobiochemistry of the Ural Scientific Research Veterinary Institute, a structural unit of the Federal State Budgetary Budgetary Institution "Urfanits UrO RAS".

Histological examinations were performed according to the design of the experiment. On the 10th, 20th, 35th day of the experiment (3 heads from each group) and on the day of slaughter – 42 days (4 heads from each group), euthanasia and autopsy of broiler chickens were performed, thymus, spleen and bursa of Fabricius were selected. Pieces of tissue for research were fixed in 10% neutral formalin. Histological preparations were made according to the standard procedure for light microscopy [8, 9]. Histological preparations were stained with hematoxylin and eosin. For the manufacture of preparations, the material was excised into pieces 3-5 mm thick, fixed in a 10% solution of neutral buffered formalin, wiring was carried out according to a standard procedure (Epredia STP 120 carousel type histoprocessor) [8, 9]. After wiring, the pieces were encased in paraffin. Sections with a thickness of 3 microns (microtome – Microm HM450) were made from paraffin blocks. The staining was carried out according to standard methods: dewaxing, staining in Carazzi hematoxylin and eosin (10:2 min), followed by purification in alcohols, clarification in xylene and encapsulation in synthetic resin. The micro-preparations were viewed using an Olympus BX 43 microscope (Olympus, Japan) with an ADF Professional 03 digital camera (ADF, USA).

Statistical processing of empirical data was carried out using the IBM SPSS Statistics program. The differences were considered statistically significant at p< 0.05.

### 3 Research results

During the experiment, a daily assessment of the general condition and behavioral reactions of broiler chickens, reactions to stimuli (sound, light) was carried out. According to the results of bird observation, there were no differences between the groups – all individuals were active, showed interest, consumed food and drank water equally willingly. During the entire growing period, symptoms of intoxication in broiler chickens of both the control and experimental groups were not recorded.

The safety of broiler chickens in the control group was 93.3%. The death of 2 individuals occurred during the first week of life, and no macroscopic signs of the development of infectious diseases were found upon autopsy. In the experimental group, when drinking the feed additive "Amber Chill feed supplement", the safety was 100%, which may indicate an improvement in metabolic processes in the body.
As a result of the weekly assessment of the dynamics of the live weight gain of broiler chickens, no statistically significant differences between the studied groups were revealed.

Histological examination of preparations of the thymus, liver, spleen and bursa of Fabricius of broiler chickens of the control group revealed the age aspect:

The structure of the thymus in chickens of the control group on day 10 is represented by a lobular structure with well-defined cortical and cerebral zones. The cortical zone prevails over the cerebral one and consists of tightly adjacent lymphocytes. Single reticuloepithelial cells are visualized in the brain area, which combine into immature Ghassal corpuscles. The connective tissue layers between the individual lobules are thin and only in the area of the thymus gate they are more extensive with the presence of venous and arterial blood vessels.

In the thymus of chickens of the control group, on day 20, there is an active proliferation of fatty tissue and atrophy of thymus lobules trapped in overgrown fatty tissue. The cortical zone of the thymus is sharply expanded, and single Ghassal corpuscles are found in the cerebral zone of the thymus, which are most often subjected to keratinization (Figure 1). In the interlobular zone, adipose tissue and blood vessels with a thickened wall in which disorganization processes are visible also prevail (Figure 2).

Fig. 1. Keratinization of the Ghassal corpuscle in the cerebral zone of the thymus. Stained with hematoxylin and eosin. Increase x200.

Fig. 2. Fatty degeneration of the interstitial tissue of the thymus. Stained with hematoxylin and eosin. Increase x200.

On the 35th day in the thymus, the control group observed the marginalization of layers. The cortical zone is weakly expressed, the brain zone is embedded in it in separate sections. At the same time, from the side of the cerebral zone, there is clearly an overgrowth of the connective tissue stroma, which in some areas reaches the edge of the lobules of the thymus (Figure 3). The blood vessels of the connective tissue stroma of the thymus are filled mainly with elements of white blood (Figure 4).
In the thymus of broiler chickens of the control group on day 43, the cortical zone of the lobules is well expressed and prevails over the cerebral zone. In some lobules, the brain area is extremely small and is visible as insignificant foci in the center of the thymus lobule. In the preserved areas in the cerebral zone of the thymus, vacuolized Ghassal corpuscles or young immature single corpuscles are visible (Figure 5).

In this case, the connective tissue stroma separating the lobules from each other is represented by coarse-fibrous connective tissue with neglected blood vessels (Figure 6).

Pseudoeosinophils are found in some Ghassal bodies. In places where young Ghassal bodies are concentrated, some of them undergo the process of apoptosis and look like keratinized bodies (Figure 7).

From the side of the thymus capsule, a zone of fatty degeneration is visible as a sign of involution (Figure 8).
On day 10, a thin capsule, a significant number of reproduction centers, pulpar, follicular and trabecular arteries with a formed wall were visualized in the spleen of broiler chickens of the control group, which corresponded to age.

On day 20, a thickening of the capsule and activation of breeding foci were found in the spleen of the control group (Figure 9).

The formation of individual lymphoid follicles was visualized (Figure 10).

Reproduction centers were activated in the spleen of 35-day-old broiler chickens of the control group. Moderate blood filling is observed in the vessels of the microcirculatory bed: pulpar, follicular and trabecular. In the wall of blood vessels, especially in the trabecular, proliferation of its elements is visible, both from the endothelium and from the adventitia (Figure 11). Lymphoid follicles are also activated (Figure 12).
On day 43 in the spleen of chickens of the control group, formed lymphoid follicles surrounded by a connective tissue capsule are visible, which are usually localized in the area of the trabeculae. Follicles of different sizes are visualized and there were a significant number of them in the spleen of broiler chickens of this age. The red pulp is evenly impregnated with red blood cells. The capsule of the spleen is unevenly thickened and contains fatty inclusions (Figure 13).

Disorganization processes were observed in the wall of the trabecular vessels. The processes of endothelial proliferation and adventitia are represented in the pulp vessels (Figure 14).

Bursa of Fabricius in broiler chickens of the control group at 10 days of age is represented by well-formed follicles in which the cortical and cerebral zones are visible, with the brain zone being the widest, and the cortical more dense and narrow. Between the individual lobules of different sizes there is a connective tissue stroma containing blood vessels of different caliber with moderate blood filling (Figure 15).

The lumen of the bursa is lined with a cylindrical epithelium in a state of secretion. The follicle centers are mainly represented by large lymphocytes, prolymphocytes and a small number of lymphoblasts. Mature lymphocytes mainly predominate in the dense cortical layer (Figure 16).
In the bursa of Fabricium of 20 day-old chickens of the control group, there is an activation of the growth of the connective tissue stroma, in some areas follicles of the fabricium bursa enter its overgrown part. In most follicles in the bursa of Fabricius, there is no clear division into cortical and cerebral zones, that is, there is a marginalization of the layers (Figure 17).

At the same time, hypersecretion in the form of mucosal dystrophy of the epithelium is detected in the cylindrical epithelium of bursa of Fabricius (Figure 18). In some areas, single cystic cavities appear (Figure 19), or foci of necrosis are found (Figure 20).
By day 35, changes related to its involution occurred in bursa of Fabricius in chickens of the control group, while disorganization in the structure of follicles is visible, the cerebral and cortical zones are not clearly expressed, there is an overgrowth of interfollicular connective tissue, vacuolization of the epithelium with the formation of a significant number of microcystic cavities. At the same time, the capsule of bursa of Fabricius is in a state of active proliferation, thickens. Some follicles are sharply enlarged in volume, some decrease and fall into the ring of overgrown connective tissue (Figure 21, Figure 22). Activation of goblet-shaped epithelial cells is also observed in the excretory duct of bursa of Fabricius.

By the 43rd day, the capsule thickening and the ingrowth of connective tissue fibers into the subcapsular zone with follicle displacement were expressed in bursa of Fabricius of chickens of the control group. Wide layers of connective tissue stroma are also visible between individual follicles, and there is no clear structure of the cerebral and cortical zones in the follicles themselves (Figure 23).

In the epithelium of Bursa of Fabricius, pronounced vacuole dystrophy and the appearance of a significant number of microcystic cavities are observed (Figure 24). Hyperplastic processes are observed in certain areas of the epithelium of bursa of Fabricius.
The marginalization of the layers in the follicles of bursa of Fabricius is pronounced, while the periphery is occupied by immature lymphoid cells, and more mature lymphocytes are displaced to the center (Figure 25).

Pronounced vacuole dystrophy of epithelial cells lining the lumen of bursa of Fabricius. In some areas, the epithelium of bursa of Fabricius loses its structure.

In the connective tissue stroma, thickening of connective tissue fibers, their fibrinization and collagenization are observed, and a significant number of vessels of the microcirculatory bed are observed here (Figure 26).

In some areas, follicles enter the foci of overgrown connective tissue, which change their size and shape.

**Fig. 23.** Disorganization of the follicle layers of bursa of Fabricius. Stained with hematoxylin and eosin. Increase x200.

**Fig. 24.** Microcystic cavities and vacuole dystrophy of the epithelium of the fabricium bursa. Stained with hematoxylin and eosin. Increase x1000.

**Fig. 25.** Marginalization of layers in the follicle of bursa of Fabricius. Stained with hematoxylin and eosin. Increase x1000.

**Fig. 26.** The proliferation of interstitial connective tissue and the collagenization of fibers. Proliferation of elements in the vessel wall. Stained with hematoxylin and eosin. Increase x1000.

Histological examination of preparations of the thymus, spleen and bursa of Fabricius of broiler chickens of the experimental group using the feed additive "Amber Chill feed supplement" in the age aspect revealed:

The thymus lobules of 10-day-old chickens of the experimental group are represented by well-defined cortical and cerebral zones. The cortical zone is usually wide, represented by
lymphocytes. Lymphocytes are located loosely in the cerebral zone, both formed Ghassal corpuscles and young single Ghassal corpuscles (Figure 27, Figure 28).

In some lobules, mainly young Ghassal corpuscles are concentrated in the brain zone, that is, there is an active development of reticuloepithelial cells, indicating an active reaction of the thymus and the formation of immunity. A significant part of the thymus is occupied by its fat capsule (Figure 29). Bundles of nerve fibers are visible in it along with blood vessels (Figure 30).

Fig. 27. The structure of the thymus. Stained with hematoxylin and eosin. Increase x200.

Fig. 28. The little body of Ghassal. Stained with hematoxylin and eosin. Increase x600.

Fig. 29. Fat capsule of the thymus. Stained with hematoxylin and eosin. Increase x200.

Fig. 30. Bundles of nerve fibers in the fatty capsule of the thymus. Stained with hematoxylin and eosin. Increase x200.

In the thymus of 20-day-old broiler chickens of the experimental group, activation of processes in the brain zone is observed, blood vessels are full-blooded, and significant reproduction of single Ghassal bodies is observed. Minor areas of adipose tissue appear in the thymus stroma and in the thymus capsule (Figure 31).

In some lobules of the thymus, atrophy of the Ghassal bodies and their eosinophilic cell degeneration, signs of apoptosis are observed (Figure 32).
When studying thymus preparations by the 35th day in an experimental bird, an expansion of the brain zone of the thymus was also detected, but at the same time, activation of both single and mature Ghassal bodies was clearly observed (Figure 33).

The layers of connective tissue between the lobules are presented in the form of narrow strips, blood vessels located there in a state of moderate blood supply, and contain an insignificant number of red blood cells (Figure 34).

The boundary between the cortical and cerebral zones is well defined, but the cerebral zone prevails.

In the thymus of chickens of the experimental group on day 43, its structure is clearly visible and in each of the lobules the cerebral and cortical zones are expressed, they are approximately equivalent in size. In the cerebral zone of the thymus, active proliferation of young Ghassal bodies is observed, while in mature Ghassal bodies, the processes of keratinization of epithelial cells are visible (Figure 35, Figure 36). A significant number of young Ghassal bodies with the simultaneous presence of mature bodies indicates an active immunobiological reaction of this organ.

From the side of the thymus capsule, a significant deposition of adipocytes is visible, which indicates involutive processes in the thymus, nevertheless, no fatty degeneration was
detected in the connective tissue stroma of the thymus, which once again confirms the high immunobiological activity of the thymus and participation in protective immunological reactions of the body (Figure 37).

In some areas of the thymus, foci of hemorrhagic impregnation are observed in places of significant location of young Ghassal bodies, which is associated with the active formation of Ghassal bodies and increased permeability of the capillary wall (Figure 38).

![Figure 35.](image1) **Fig. 35.** The presence of a significant number of young Ghassal bodies in the cerebral zone of the thymus. Stained with hematoxylin and eosin. Increase x1000.

![Figure 36.](image2) **Fig. 36.** Keratinization processes in the mature body of Ghassal. Stained with hematoxylin and eosin. Increase x1000.

![Figure 37.](image3) **Fig. 37.** A capsule of the thymus with adipocytes. Stained with hematoxylin and eosin. Increase x200.

![Figure 38.](image4) **Fig. 38.** The focus of hemorrhagic impregnation in the hyperplasia zone of young Ghassal bodies. Stained with hematoxylin and eosin. Increase x200.

A thin connective tissue capsule is visible in the structure of the spleen of 10-day-old broiler chickens of the experimental group. Unlike the chickens of the control group, pseudoeosinophil cells are perivascularly visible directly under the capsule, indicating some allergization of the chickens' body (Figure 39).

In the trabeculae of the spleen, blood vessels are mainly of the arterial type with a clearly contoured wall. The pulp of the spleen is represented by densely arranged lymphoid cells. Reproduction centers with concentrically arranged histiocytic elements are viewed (Figure 40).
By day 20, active proliferation of lymphoid follicles was detected in the spleen of broiler chickens of the experimental group. The breeding centers are activated (Figure 41). The arterial vessels located in the trabeculae of the spleen contain all its components, endothelium, argyrophilic membrane and layers of adventitia (Figure 42).

By day 35, there were no significant changes in the spleen of the chickens of the experimental group, reproduction centers and mature lymphoid follicles were also visualized. The structure of the spleen on day 43 in broiler chickens of the experimental group has not been changed, both the red pulp and the white pulp represented by the reproduction centers and pulpar blood vessels are visible in it. It is moderately blood-filled, contains a significant number of mature well-defined lymphoid follicles (Figure 43).

The trabeculae of the spleen contain large blood vessels with a clearly defined pattern of their walls and moderate blood filling. Here, nerve nodules can be seen in the trabeculae (Figure 44).

The capsule of the spleen is uniformly thickened in some parts of it, clusters of adipocytes are visible, blood vessels are in a state of moderate blood supply here.
In bursa of Fabricius of 10 day-old chicks of the experimental group, in contrast to the control group, breeding centers are visible in most follicles. The cortical and cerebral zones are clearly visible, while the presence of pseudoeosinophils is visible in the cerebral zone (Figure 45).

As well as in chickens of the control group, the epithelium is in a state of secretion, but single microcystic cavities appear in some areas of the epithelium (Figure 46).

The blood vessels of the stroma are moderately blood-filled (Figure 47).

In the connective tissue base of the bursa, along with blood vessels of different calibers, there are nerve clusters and excretory ducts of the bursa (Figure 48).

In the chickens of the experimental group, compared with the control group, the boundary between the cortical and cerebral layers is most clearly visible.
By day 20, the structure of the lymphoid follicles of bursa of Fabricius of broiler chickens of the experimental group has not been changed, the cortical and cerebral zones are clearly visible, with active proliferation of lymphoid cells in the cerebral zone (Figure 49).

In the epithelium of bursa of Fabricius, cystic cavities are detected in the same way as in the bird of the control group. The epithelium is in a state of active secretion (Figure 50).

The capsule of bursa of Fabricius contains a small amount of fatty inclusions in the form of fat lobules and blood vessels of various calibers (Figure 51).

In the excretory duct of bursa of Fabricius, activation of goblet cells with their increased secretion is observed (Figure 52).
In bursa of Fabricius of 35 day-old broiler chickens of the experimental group, the processes of involution are also visible, however, in the follicles themselves the boundary between the cortical and cerebral zones is visible, in the latter the processes of proliferation of lymphoid elements are visible (Figure 53).

Microcystic cavities are also found in the epithelial lining of bursa of Fabricius, which corresponds to the process of involution.

At the same time, the connective tissue stroma is also in a state of active proliferation, there are separate areas with adipocytes in it (Figure 54). The same processes occur in the capsule of bursa of Fabricius (Figure 55).

When examining the organ at low magnification (increase x100), a folded structure is visualized, where the parenchyma and stroma of each fold are clearly visible (Figure 56).
In bursa of Fabricius of chickens of the experimental group, the structure of both follicles and the epithelium of the lumen was clearly preserved on day 43. In the structure of the bursa follicles, its cortical and cerebral layers are visible and the boundary between them is outlined. The cerebral layer of the follicles is enlightened and the proliferation of lymphoid-cellular elements is visible in it. This layer is wider than the cortical layer. Follicles are usually large, in some of them one can observe the formation of the "follicles in the follicle" type, connective tissue of different thickness between the follicles, but as a rule these are narrow strands of connective tissue separating the follicles from each other (Figure 57).

The connective tissue capsule of the bursa is not the same thickness in its different sections, but it is always homogeneous. The blood vessels located in it are moderately hyperemic or desolate. In some areas, it contains fat accumulations that are clearly outlined (Figure 58).

The connective tissue stroma contains a significant number of blood vessels of the capillary, precapillary type, which indicates the processes of proliferation associated with the involution of bursa of Fabricius. Nevertheless, judging by the size and number of follicles, the involutive processes are poorly expressed (Figure 59).

In the epithelium lining the lumen of bursa of Fabricius, single microcystic cavities and minor vacuole dystrophy of epithelial cells are found (Figure 60).
Fig. 57. "Follicles in the follicle" of the bursa of Fabricius with a clearly defined boundary between the cortical and cerebral zones. Stained with hematoxylin and eosin. Increase x200.

Fig. 58. Fat accumulations in the connective tissue capsule of bursa of Fabricius. Stained with hematoxylin and eosin. Increase x200.

Fig. 59. Vessels of different calibers in the connective tissue stroma of bursa of Fabricius. Stained with hematoxylin and eosin. Increase x200.

Fig. 60. Vacuole dystrophy of epithelial cells. Stained with hematoxylin and eosin. Increase x1000

4 Conclusion

The inclusion of the feed additive "Amber Chill feed supplement" in the diet of broiler chickens did not have a negative effect on the general condition, safety of poultry, and live weight gain. The hematological parameters of broiler chickens of the control and experimental groups were within the reference values.

Histological examination revealed that the organs of the immune system - thymus, spleen and bursa of Fabricius under the action of the feed additive "Amber Chill feed supplement" not only underwent an active involutive process by the end of the technological cycle - 43 days, but on the contrary, activation processes were expressed in it, both the T-system and the B-system of immunity, this it manifested itself in the activation of the lymphoid follicles of the fabricius bursa, an increase in the number of young single Ghassal bodies in the thymus and the number of mature lymphoid follicles in the spleen. Signs of involution in the form of an overgrowth of connective tissue stroma and fatty metaplasia were insignificant, which
once again confirms the positive effect of the tested feed additive "Amber Chill feed supplement" on the body of broiler chickens over the growing period.

References

4. Maria Zhuravleva, Quantitative characteristics of the indicators of the immune response in chickens to various types of antigens: dis. candidate of Veterinary Sciences: 02/06/02 (Moscow, 2014) 174.
15. N. Travnikova, Comparative morphology of the fabricium bursa of broiler chickens in the age aspect with different methods of maintenance: abstract. ...Candidate of Veterinary Sciences: 16.00.02 (Yekaterinburg, 2004) 21.